

In the Claims

1. (Currently Amended) A halftone processor for converting a gray scale image comprising a plurality of m-bit pixels to a halftoned image comprising a plurality of n-bit pixel images, where m > n, the processor comprising:

a memory storing a stochastic screen, the stochastic mask being a stochastic screen constrained by a checkerboard pattern, the checkerboard pattern constrained stochastic screen comprising a set of threshold values, each threshold value in the checkerboard pattern constrained stochastic screen corresponding to a gray level, each threshold value corresponding to a gray level between a first gray level (g_{s1}) and a second gray level (g_{s2}) being positioned in the checkerboard pattern constrained stochastic screen at a pixel position corresponding to a black pixel position in the checkerboard pattern, each threshold value corresponding to a gray level between the second gray level (g_{s2}) and a third gray level (g_{s3}) being positioned in the checkerboard pattern constrained stochastic screen at a pixel position corresponding to a white pixel position in the checkerboard pattern, the first gray level (g_{s1}) being greater than the second gray level (g_{s2}), the second gray level (g_{s2}) being greater than the third gray level (g_{s3}), the third gray level (g_{s3}) corresponding to a black dither of 50% or less for gray levels (g_s) wherein $x < g_s < y$, x corresponding to 100% black, y corresponding to 0% black; and

a comparator receiving the gray scale image and the set of threshold values corresponding to the checkerboard pattern constrained stochastic screen, the comparator comparing, on a pixel-by-pixel basis, a value of each pixel in the gray scale image to a corresponding threshold value in the checkerboard pattern constrained stochastic screen to produce the halftoned image; wherein substantially all the threshold values corresponding to gray levels between g_{s1} and g_{s2} coincide with black positions in a constraining checkerboard pattern and substantially all the threshold values corresponding to gray levels between g_{s2} and g_{s3} coincide with white positions in the constraining checkerboard pattern, wherein $g_{s1} > g_{s2} > g_{s3}$ and wherein the gray level g_s corresponds to a black dither of 50% or less for gray levels $0 < g_s < 2^m$, wherein $g_s = 0$ corresponds to 100% black and $g_s = 2^m$ corresponds to 0% black.

2. (Original) The processor of claim 1, wherein the halftoned image comprises a plurality of 1-bit pixels.

3. (Currently Amended) The processor of claim 1, wherein the first gray level (g_{s1}) corresponds to approximately a 5% black dither and the second gray level (g_{s2}) corresponds to approximately a 40% black dither.

4. (Currently Amended) The processor of claim 1, wherein the second gray level (g_{s2}) corresponds to approximately a 40% black dither and the third gray level (g_{s3}) corresponds to approximately a 50% black dither.

5. (Currently Amended) The processor of claim 1, wherein the first gray level (g_{s1}) corresponds to approximately a 5% black dither, the second gray level (g_{s2}) corresponds to approximately a 40% black dither and the third gray level (g_{s3}) corresponds to approximately a 50% black dither.

6. (Currently Amended) A method of generating a halftone screen for converting an image received at d levels, for reproduction at c levels, where d > c, the method, in optional sequence, including:

(A)—generating an initial stochastic screen pattern for a first gray level, the initial stochastic screen pattern being constrained by a checkerboard pattern such that a black pixel in the first initial checkerboard pattern constrained stochastic screen pattern is positioned in the first initial checkerboard pattern constrained stochastic screen pattern at a pixel position corresponding to a black pixel position in the checkerboard pattern—designed to provide a visually pleasing, blue noise dot pattern when thresholded and wherein substantially all black pixels in the initial screen pattern correspond to black pixels in a constraining checkerboard pattern;

(B) generating a plurality of subsequent first checkerboard pattern constrained stochastic screen patterns, each subsequent first checkerboard pattern constrained stochastic screen pattern subsequent screen pattern corresponding to a specific gray level that is darker than the first gray level and is lighter than a second gray level, the second gray level being darker than the first gray level, each subsequent first checkerboard pattern constrained stochastic screen pattern the subsequent screen pattern maintaining an the arrangement of black pixels of any the first initial checkerboard pattern constrained stochastic screen pattern, each subsequent first checkerboard pattern constrained stochastic screen pattern corresponding to a lighter gray level and further including a number of additional black pixels such that a total number of black pixels in a subsequent first checkerboard pattern constrained stochastic screen pattern is greater than a number of black pixels in the initial checkerboard pattern constrained stochastic screen pattern, each additional black pixel in the subsequent first checkerboard pattern constrained stochastic screen patterns being positioned in the subsequent first checkerboard pattern constrained stochastic screen pattern at a pixel position corresponding to a black pixel position in the checkerboard pattern at least one more black pixel, wherein the least one more black pixel is at a location corresponding to a black pixel in the constraining checkerboard pattern; (C) repeating (B) for a plurality of specific gray levels between the first gray level and a second gray level;

generating a second checkerboard pattern constrained stochastic screen patterns, the second checkerboard pattern constrained stochastic screen pattern corresponding to the second gray level, the second checkerboard pattern constrained stochastic screen pattern maintaining the arrangement of black pixels of the first initial checkerboard pattern constrained stochastic screen pattern, the second checkerboard pattern constrained stochastic screen pattern including a number of additional black pixels such that a total number of black pixels in the second checkerboard pattern constrained stochastic screen pattern is greater than a number of black pixels in the initial checkerboard pattern constrained stochastic screen pattern, each additional black pixel in the second checkerboard pattern constrained stochastic screen patterns being

positioned in the second checkerboard pattern constrained stochastic screen pattern at a pixel position corresponding to a black pixel position in the checkerboard pattern; and

(D) generating a plurality of subsequent second checkerboard pattern constrained stochastic screen patterns, each subsequent second checkerboard pattern constrained stochastic screen pattern second-subsequent screen pattern corresponding to a specific gray level that is darker than the second gray level and is lighter than a third gray level, the third gray level being darker than the second gray level, each subsequent second checkerboard pattern constrained stochastic screen pattern the second-subsequent screen pattern maintaining an the arrangement of black pixels of every the second checkerboard pattern constrained stochastic screen pattern, each subsequent second checkerboard pattern constrained stochastic screen pattern corresponding to a lighter gray level and further including a number of additional black pixels such that a total number of blacks in a subsequent second checkerboard pattern constrained stochastic screen pattern is greater than a number of black pixels in the second checkerboard pattern constrained stochastic screen pattern, each additional black pixel in the subsequent second checkerboard pattern constrained stochastic screen patterns being positioned in the subsequent second checkerboard pattern constrained stochastic screen patterns at a pixel position corresponding to a white pixel position in the checkerboard pattern at least one more black pixel, wherein the least one more black pixel is at a location corresponding to a white pixel in the constraining checkerboard pattern; and (E) repeating (D) for a plurality of gray levels between the second gray level and a third gray level wherein the third gray level corresponds to a black dither of 50% or less.

7. (Original) The method of claim 6, wherein the first gray level corresponds to approximately a 5% black dither and the second gray level corresponds to approximately a 40% black dither.

8. (Original) The method of claim 6, wherein the second gray level corresponds to approximately a 40% black dither and the third gray level corresponds to approximately a 50% black dither.

9. (Currently Amended) A method for converting a gray scale image received at d levels, for reproduction at c levels, where d > c, the method, in optional sequence, including:

receiving the gray scale image including a plurality of pixels; and

comparing, on a pixel-by-pixel basis, a value of each of the pixels in the gray scale image to a corresponding threshold value in a stochastic screen, the stochastic screen being constrained by a checkerboard pattern, the checkerboard pattern constrained stochastic screen comprising a set of threshold values, each threshold value in the checkerboard pattern constrained stochastic screen corresponding to a gray level, each threshold value corresponding to a gray level between a first gray level (g_{s1}) and a second gray level (g_{s2}) being positioned in the checkerboard pattern constrained stochastic screen at a pixel position corresponding to a black pixel position in the checkerboard pattern, each threshold value corresponding to a gray level between the second gray level (g_{s2}) and a third gray level (g_{s3}) being positioned in the checkerboard pattern constrained stochastic screen at a pixel position corresponding to a white pixel position in the checkerboard pattern, the first gray level (g_{s1}) being greater than the second gray level (g_{s2}), the second gray level (g_{s2}) being greater than the third gray level (g_{s3}), the third gray level (g_{s3}) corresponding to a black dither of 50% or less for gray levels (g_s) wherein x < g_s < y, x corresponding to 100% black, y corresponding to 0% black, wherein substantially all the threshold values corresponding to gray levels between g_{s1} and g_{s2} coincide with black positions in a constraining checkerboard pattern and substantially all the threshold values corresponding to gray levels between g_{s2} and g_{s3} coincide with white positions in the constraining checkerboard pattern, wherein g_{s1} ≥ g_{s2} ≥ g_{s3} and wherein the gray level g_{s3} corresponds to a black dither of 50% or less for gray levels 0 < g_s < 2^m, wherein g_s = 0 corresponds to 100% black and g_s = 2^m corresponds to 0% black.

10. (Currently Amended) The method of claim 9, wherein the first gray level (g_{s1}) corresponds to approximately a 5% black dither and the second gray level (g_{s2}) corresponds to approximately a 40% black dither.

11. (Currently Amended) The processor of claim 9, wherein the second gray level (g_{s2}) corresponds to approximately a 40% black dither and the third gray level (g_{s3}) corresponds to approximately a 50% black dither.

12. (Currently Amended) The processor of claim 9, wherein the second gray level (g_{s2}) corresponds to approximately a 40% black dither.

13. (Currently Amended) The processor of claim 9, wherein the first gray level (g_{s1}) corresponds to black dither of less than 15%.

14. (Currently Amended) The processor of claim 1, wherein the second gray level (g_{s2}) corresponds to approximately a 40% black dither.

15. (Currently Amended) The processor of claim 1, wherein the first gray level (g_{s1}) corresponds to black dither of less than 15%.